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ABSTRACT

This bulletin of the Scottish Schools Science Equipment Research Centre provides information to teachers on a variety of topics relating to the use of equipment in science instruction. The introductory remarks deal with an assessment of electronic calculators suitable for use in schools. The section entitled "Physics Notes" lists surplus physics equipment available to schools at the Research Centre and discusses the disposal of radioactive materials, an inductive reactance demonstration, and the use of filter pumps. In the section dealing with biology, the use of Clinistix and Albustix in testing food is outlined. "Chemistry Notes" provide suggestions to teachers on explosive gas mistures, the storage of sulfur dioxide cylinders, and the construction of a pipette filler based on a disposable syringe. A list is also provided of the equipment that has been tested by the Consortium of Local Education Authorities for the Provision of Science Equipment (CLEAPSE). Reports of these tests are available for examination by science teachers. (JR)

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SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

SE 016 773

Bulletin No. 64. July, 1973.

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Introduction

In the last bulletin we intimated that Colin Weatherley had been seconded to work on the teaching of biology to blind children for a period of a year. We can now report that the temporary vacancy as Assistant Director of Biology is to be filled by Mr. John Richardson, B.Sc., M.Sc., who is at present Principal Teacher at Bydale's School, Redcar, Yorkshire. He will join SSSERC in time for the start of the 1973-74 school session.

* * * * *

At the last meeting of the Development Committee a decision was taken that we should examine and report on electronic calculators for use in science departments. The committee feel that there is a need for such a machine to be in a laboratory so that when pupils have finished an experiment they can go to this machine and perform such calculations as may be necessary. This implies that the maximum scale of equipping a school with calculators should be one per laboratory, and that they should be of the simplest type, performing the four basic arithmetic operations. In fact, any machines we have examined usually supply some additional facility, such as the calculation of percentages, or repeated calculations with a constant such as would be required if converting a number of imperial to metric measurements. While there may be a need, and we are not sure that there is, for a more sophisticated instrument with one or more memory stores, able to extract square roots and calculate trigonometric functions, we do not intend examining these at the present time.

Assessing desk calculators is unlike most other assessments we have undertaken. If they go wrong they are usually irreparable, apart from the possibility of replacing the light emitting diodes which are the usual form of display. Reliability is therefore something which we would find difficult to assess, except through experience in use. It is known that the components in these calculators are highly reliable and that if they survive the first few months, which would normally be covered by a guarantee, then they give many years service.

We therefore propose a user type assessment, where the calculators will be sent to schools and pupils will be asked to perform a series of calculations, writing down their answers. Here we shall try to find which instruments have the most trouble free buttons, and most easily read display. There are other questions which only teacher opinion can answer. Mains vs battery operated models - is the advantage of portability outweighed by the nuisance of battery charging (which can be eliminated by using rechargeable batteries), the risk of theft or of mechanical damage through being dropped? Opinions on these and similar questions we would like to have from teachers who have used calculators.

Physics Notes

The following items of surplus equipment are offered for the first time. Since it is some time since surplus equipment has been offered in a bulletin, we would repeat here that we are prepared to hold any item for a school until the necessary paper-work can be sent, even if this means the annual requisition. We therefore strongly advise any teacher wishing to purchase items for which the demand may exceed the supply to make a telephone call reserving the item in his name. Also we can assure teachers that all items listed below are in stock when the bulletin is posted from the Centre. The only advantage to teachers who visit us and know in advance what will be made available is that they are on the watch for the arrival of the bulletin in their school.

Item 337 Soxhlet extractor, Quickfit EX5/53, 50p

Item 338 Spatula, stainless steel with wooden handle, 250 x 38mm, 25p

Item 339 High Vacuum stopcock, Springham STV/10B, 10mm bore, 50p

Item 340 High Vacuum stopcock, Quickfit TH1/10L, 10mm bore, 50p

Item 341 Rubber stoppers, solid, bottom dia. 5mm, ½p

Item 342 Specimen tubes glass, corked, 25mm dia. 25mm long, 1p

Item 343 Pyrex glass capillary tubing, 6 x 0.75mm, or 7 x 1mm, dia. x bore, 1.5m lengths, per length 5p

Item 344 Medium wall pyrex tubing, all in 1.5m lengths, outside diameter 8, 11, 14 and 15mm, per length 5p

Item 345 Light wall pyrex tubing, outside dia. 28mm, 1.5m lengths, per length 20p

Item 346 Transparent silica tubing, 1m lengths, 25mm dia. per length £1

Item 347 Emergency Hand Lamp, HL50 by Bardic Systems, 2.5V, 15W, contains alkaline cells and mains operated charging unit, £1

Item 348 Electrolytic capacitors, 50μF, 6V; 27μF, 2.5V; 25μF, 25V; 250μF, 25V; 500μF, 50V; 8μF, 800V; 32μF, 375V; all at 5p

Item 349 Variable transformer, 240V input; 0-250V, 20A output, £5

Item 350 Semiconductor signal diodes, OA10, OA47, OA90, Z6, Z7, all at 2p

Item 351 Semiconductor power diodes, BYZ13, BYX38, ZS31B, ZHS103, all at 5p

Item 352 Zener diodes, Z2A33F (3.3V). Z2A36F (3.6V). 22A56F (5.6V), BZY88 (5.9V), all at 2p

Item 353 Transistors OC44. OC76, ACY19. ACY21, AFZ12. ASZ20, 2N1306. 2N3766, V15/20IP. all at 5p

Item 354 Minature wire-ended neon indicator CC3L, 2p

Item 355 Voltage stabiliser tubes QS75/20, QS95/10, VR105/30, M8223, all at 2p

Item 356 Dekatron numerical indicator tubes, UX9194. E1T (CV5106), 50p

Item 357 G.M. Tube 2B2, working voltage 1500V, window weight 2.1 mg/cm^2, £2

Item 358 Multi-range D.C. ammeter, mirror backed scale, length 90mm, FSD 100mV, with external shunts for 5, 20 and 200A, £2

Item 359 Dry batteries, grid bias 9V type, 1½V No. 8, 1.35V mercury cells, 67½V, 150V, all at 1p

Item 360 Dry batteries, multi-tapped, 150/90/40/-8.1/-2.7/-1.3V, octal base; 99/72/54/9V, wander plugs, both types 5p

Item 361 Lead-acid batteries 12V, 22Ah, £1

Item 362 Moving coil meters, panel mounting, FSD 200µA, 2mA (scaled 0-35kv), 15mA, all at 50p

Item 363 Printed circuit boards, containing at least 12 transistors, mostly CV7004 (OC45), 25p.

* * * * *

Some time ago we were asked to advise a College of Further Education on the disposal of a radio-active source. This was the mini-generator source marketed by Griffin and George, and consists of a long-life parent and a short-life daughter isotope. To use the source the daughter isotope is eluted out in solution; after several hundred such elutions the concentration of the daughter isotope becomes so low that the source is useless for experiments and has to be disposed of. The college found that Griffin and George would not accept it for disposal, and they eventually got rid of it through their local university physics department.

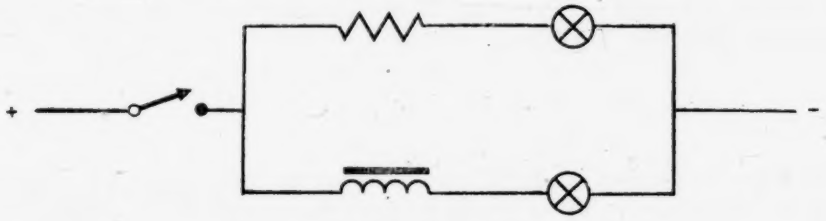
We have since made enquiries, and since it is a situation which may recur either in schools or in colleges of further education, we feel that the information we obtained should be known to all teachers handling radio-active sources. The National Radiological Protection Board will accept for disposal any radioactive source; prior permission to move the source must be obtained from the Scottish Development Department. A charge may

be made for this service. The NRPB was set up under the Radiological Protection Act, 1970 "to advance the acquisition of knowledge about the protection of mankind from radiation hazards and to provide information, advice and services to persons with responsibility in radiological protection"* The NRPB are also the people to contact in the unlikely event of a leakage of radio-active material from a sealed source, or if a teacher suspects that a leakage may have taken place. Part of their service consists in monitoring customers' premises for radiation, and giving advice on remedial measures.

*Services available from the NRPB, Issue No. 2 (January, 1973). NRPB, Harwell, Didcot, Berks, OX11 ORQ.

* * * * *

An experiment which shows the 'choking' or inertial effect of inductance can be set up using the circuit given below. Essentially, current is switched simultaneously into an inductance and a resistance in parallel, and the slower rise of current in the inductor is shown by the delayed brightening of the lamp in that branch of the circuit, compared with the other lamp. The lamps we used were RS Components 6V, 60mA, chosen for their low current consumption so that the voltage required when in series with a few hundred ohms would not be unduly high. Experiments with a number of inductors showed that 5H is about the minimum inductance which will show the effect, and the experiment is really much more convincing if 10H or even 20H is used. Once the inductor has been selected, the resistance in that branch of the circuit should have the same value as the resistance of the choke, which will normally be between 100 and 500Ω. This ensures that both lamps will be equally bright when steady DC is flowing in the circuit.



The experiment can be carried out in a variety of ways. If an old smoothing choke, not required for another purpose is to be used, the equipment can be built up as a set piece on a display board, and R can be a fixed resistor, chosen to match the choke resistance and if necessary compounded of several resistors. An advantage of this layout is that the wiring can clearly show the parallel nature of the circuit, and the effect is obvious immediately upon switching on the D.C. supply. If the experiment is wired up on the bench immediately prior to use, then R should be a 500Ω wirewound potentiometer, and there must be a preliminary adjustment of R to achieve equal brightness of the lamps before switching off and on again to show the effect. This introduces a complication; it may be that after the first passage of current the core of the choke will retain some of its magnetism, thus

making it easier to establish the field when current is again switched on, and so speeding up the brightening of the lamp and rendering the delay less obvious. This 'defect' can be put to good use, of course, by surreptitiously reversing the connections to the choke after the adjustment for equal brightness of the lamps has been made. The residual field has then to be destroyed before a field in the reverse direction can be established, and this appreciably delays the brightening of the lamp.

The primary of a mains transformer is an inductance of the right order of magnitude, and the teacher should try a variety of these to see if any will suit. We experimented with a large number, usually the transformer on various types and models of power supply unit, but found none that was really convincing. All showed the residual magnetism effect to a greater degree than the few chokes we had available, and on all of them the effect, barely noticeable at first switching, was practically non-existent on subsequent switchings. On the other hand, if one cheated by reversing connections to the transformer at each throw the effect was quite noticeable. Perhaps of all the units tried the mains input side of the Radford Labpack and Radford N59R power units showed the effect best, although whether the pupils will understand what is happening when the mains plug of either of these is connected into the circuit, is a moot point. It would seem that the RS Components 'hygrade' choke, 10H and 285Ω would be a convenient component to use although we have not tested this so far. The disadvantage is that for full brightness of the lamp, the power supply will need to be 23V. Incidentally we found no difference between using batteries and a bridge-rectified, unsmoothed supply when doing the tests.

* * * * *

The extract below from a recent CLEAPSE bulletin will be of particular interest to teachers in those parts of the country which have a water shortage.

Recently, in our investigation into filter pumps, we measured the water consumption of a typical water operated filter pump, and were surprised to record a rate of 4.5 litres per minute (1 gallon/minute). In view of the need to conserve water and, when supplies are metered, the cost, we are asking teachers and technicians to use water operated filter pumps only when really necessary, and for as short a time as possible.

Biology Notes

For some years we have been urging the increased use of Clinistix and Albustix, which are used medically for urine testing, as indicators for glucose and protein respectively. Since the chemistry of the tests is not discussed it becomes a cookery book exercise, for which one recipe is as good as the next provided that

it gives results. Albustix we certainly believe to be superior to Millon's reagent, particularly from the point of view of safety and time, and the costs are comparable.

Food	Starch	Fat	Glucose	Protein
Jam	-	+	+++	-
Crisps	+++	++	-	Trace
Bread	+++	++	-	+
Sweet biscuit	+++	++	+++	+
Cream cracker	+++	+	+	+
Cheese	-	++	-	+++
Sausage	++	+	++	+
Mincemeat	-	+	-	+++
Peanuts	+	+++	-	[illegible]
Egg White	-	-	+++	+++
Milk	-		-	+++
Milk chocolate	-		+	++
Butter	-	+++	-	-
Banana			++	Trace
Apple			+++	-
Grape			+++	-

Table 1. Degree of response to food tests on different food stuffs. The number of + marks indicates the degree of response; these correspond to the colour chart of the Albustix bottle. Colours are charted on the Clinistix bottle as Light; Medium; and Dark, which are here translated to +; ++; and +++ respectively. A - indicates no response, and in a few cases a blank space indicates that this test was not carried out. The degrees of response to the standard test for fat and starch are a purely subjective estimate on a comparison of the intensity of response with the different foods.

The case for Clinistix is not so clear-cut, and in Bulletin 54 we recommended Benedict's solution rather than Clinistix for food tests. This was partly on grounds of cost, but also because we felt that it was necessary to detect other reducing sugars, as well as non-reducing sugars. Since the latter procedure involved boiling with dilute hydrochloric acid we felt that one might as well boil with Benedict's solution afterwards. However, we now feel

that detection of glucose alone is probably sufficient. This being so, it is clearly an advantage to use tests which do not require heating. The difference in cost between Clinistix and Benedict's solution is still a factor, but we feel that the gains in time, convenience and safety probably justify the extra cost.

We have now extended the work described in Bulletin 54 to cover the standard tests for starch and fats, and to make the tests semi-quantitative. We believe that this work should be done on a pupil scale, it should be as brief and uncomplicated as possible, and it should be safe. We also assume that it is not essential to test for sugars other than glucose. The procedure described has been tried on the 16 food stuffs listed in Table 1.

Food	Protein content	Albustix result
Egg white	43	+++
Peanut	29	+++
Milk	28	+++
Cheese	26	+++
Mincemeat	15	+++
Milk chocolate	>6*	++
Sausage	9	+
Bread	8	+
Cream cracker	8	+
Sweet biscuit	6	+
Crisps	approx 3	Trace
Banana	1	Trace
Jam	0.7	-
Butter	0.4	-
Apple	0.4	-
Grape	0.4	-

Table 2. Albustix result compared with protein content.

*6 is the figure given for plain chocolate.

Each food was placed in a separate plastic specimen tube and mashed up in about 5ml of water with a glass rod to form a thick suspension. The specimen tubes were conveniently held in a slightly compressed form of the wire mesh test tube rack described in Bulletin 52. One or two of the foods, e.g. peanut, did not respond to this treatment and had to be ground with a pestle and mortar before being transferred to the specimen tube. About 2ml of suspension were then transferred to clean tubes, and the iodine test for starch carried out. The remaining part was tested for glucose and protein by dipping in Clinistix and Albustix respectively. Colour changes of the -stix were recorded after one minute. A further portion of the dry food was added to a clean specimen tube and mashed up with a glass rod in 2ml of ethanol, before carrying out the standard ethanol test for fat. The results of all four tests are shown in Table 1.

We were able to compare the results obtained with Albustix, with the actual protein contents of the foodstuffs as derived from the food tables in Nuffield Biology Year III Test, Chapter 4. The comparisons are given in Table 2, from which it can be seen that the Albustix gave worthwhile semi-quantitative results. (We had no information on glucose contents).

The instructions on the albustix and Clinistix bottles state that readings must be taken immediately, but this of course refers to protein and glucose in urine. Leaving the -stix in the food suspension for one minute does not invalidate the procedure since many of the foods - e.g. butter and jam - provide adequate controls.

In the school laboratory we would envisage a pair of pupils testing perhaps three foodstuffs as well as the type chemicals - each pair testing no more than one food requiring a pestle and mortar. We feel that the use of Albustix and Clinistix should allow these tests to be completed well within a double period, hopefully leaving time for the teacher to round off with a demonstration of the DCPIP test for vitamin C. Much of the stimulus for this work was provided by the 'Energy for Life' unit produced by the Australian Science Education Project. This project is still in the trials stage, so that the material is unfortunately not yet generally available in this country. We have, however, been advised that negotiations are in hand to have the material published in the UK, but that it will probably be two years before it is in print.

Cleapse Reports

CLEAPSE, a contraction of Consortium of Local Education Authorities for the Provision of Science Equipment, is an organisation operating in the southern half of England with aims similar to SSSERC, and is the older organisation by some eighteen months. Like us, they produce information sheets and reports on manufacturers' apparatus which they have tested, and like us they are required to keep such information confidential to their members to limit the possibility of legal action by an aggrieved manufacturer. The two organisations do however have a knock-for-knock arrangement, which means that CLEAPSE reports are available to SSSERC members under the same conditions as the SSSERC reports.

In Bulletin 33 we published a list of CLEAPSE reports which members could borrow from us, and we are bringing this up-to-date by giving a full list of these now available from SSSERC, and we will try to keep readers informed of new information from CLEAPSE as it becomes available. Any of these reports or information sheets can be borrowed for up to one month by writing to us quoting the report number and title; this facility does not apply to readers of the bulletin located outside Scotland.

Report No.	Date of Issue	
-	1/67	Solid Block Apparatus to measure Mechanical Equivalent of Heat
L3a	7/70	Skeletons
L3b	4/72	Ears
L3c	4/72	Eyes
L4/2	9/71	Top loading Balances up to about 1kg
L4/3	1/72	Murakami Balance
L8a	-	Introduction to Chromatography, Thin Layer Chromatography, Paper Chromatography
L8b	9/72	Chromatography Kits
L8c	-	Column Chromatography
L13	11/69	Energy Conversion Kits
L19	10/70	Kymographs
L24/1	-	Open University Microscope
L35	4/71	Low priced pH Meters
L43	1/69	Thermal Conductivity of Good Conductors
L47	4/68	Cloud Chambers
L53	11/69	Long form versions of the Periodic Table
L56	9/69	Small Mammal Cages
L59	11/68	Low Voltage Supply Units
L60	2/72	Stereomicroscopes
L61	10/69	Spark Counters
L73	1/71	Air Tables
L74	8/71	Apparatus for teaching the photoelectric effect
L75	10/70	Syringes

Report No.	Date of Issue	
L80	3/73	Flashing Light Stroboscopes
L82	10/70	Galvanometers (microamp types)
L83	4/71	Centrifuges
L86	6/70	School Laboratory Earth Leakage Protection Units
L86b	-	Crabtree P60 Earth Leakage Circuit Breaker
L86c	-	Pluguard Earth Leakage Circuit Breaker
L86d	-	Lectroguard
L87	1/72	Natural Gas Burners (Bunsen)
L105	3/73	Clare Electrical Appliance Test Set
-	1/65	Assessment of Microprojectors
-	7/67	Assessment of e/m apparatus
Information Sheets		
L32a	7/69	Ovens - up to £70
L32b	7/69	Incubators - up to £120
L32c	2/69	Incubators/Ovens - combined - up to £120
L51	10/70	Lasers
-	1/67	Commercial Deionisers
L69	4/69	Crucibles
L72	3/69	Suppliers of Biological Materials
L90	2/73	Portable Service Trolleys
L92	9/71	Ratemeters, Scalers and Scaler-timers
L94	1/73	Apparatus for investigating conductivity of solutions
L96	2/73	UV Lamps
APP/1	-	Quartz Iodine Lamp
Apparatus Notes		
L1/2	4/69	Aquarium Cooling/Cooled Trough
L10a	1/67	CLEAPSE Deioniser
L37/002	-	CLEAPSE Refrigerator Shelf Adapter
APP/8	-	CLEAPSE Rewirable Fuse
APC/11	-	A Simple Rectifier

Chemistry Notes

We have heard recently of an accident where equal volumes of town gas and oxygen were ignited in a plastic detergent bottle (Squeezy, capacity about 430ml). We would like to emphasize the great danger involved when oxygen is mixed with flammable gases. The above experiment was carried out at the Centre and the explosion was very violent. When a narrow necked container is used the explosion is much more violent than when carried out in a vessel such as a gas jar.

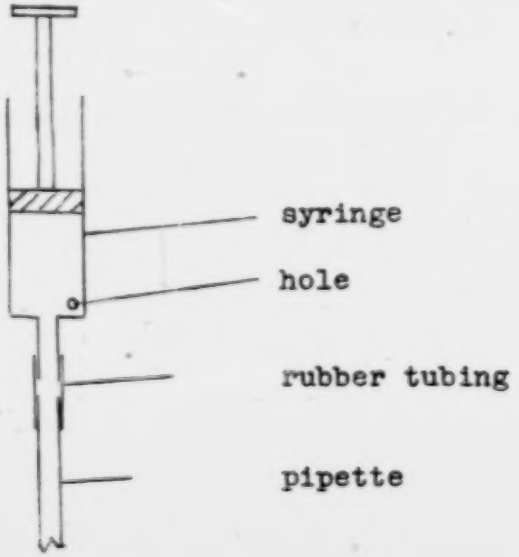
Fortunately many teachers prefer to use a light weight plastic bag for explosion experiments and this is quite acceptable as long as the teacher, or the class, do not go into competition with the class next door. We have tried equal volumes of town gas and oxygen, and the 2/1 ratio hydrogen and oxygen in different sizes of polythene bags and have found that a 240 x 125mm size is ample for the demonstration. This size of bag is also suitable for equal volume hydrogen air mixture. We would recommend that on no account should a plastic bag greater than 250mm square be used in such experiments. Our technique in exploding the mixture was to seal the plastic bag after filling by tying the neck with wire or string, using one end to tie the bag to the end of a metre stick. This was then held at arm's length and the bag held over a bunsen flame.

* * * * *

The storage of liquid sulphur dioxide in 500g aluminium canisters, used by most chemistry departments presents problems due to corrosion. When canisters are exposed to acid fumes corrosion is rapid where the brass valve fitting is in contact with the aluminium. We have found a few cases of corrosion so bad that there was a danger of rupture. Such canisters should be stored in a well ventilated area, preferably on an open shelf, and certainly not in a fume cupboard alongside bottles of acid, bromine, phosphorus(V) oxide, etc., which produce a very corrosive atmosphere which attacks the paint and finally the metal.

* * * * *

In Bulletin 32, page 7 we described the construction of a pipette filler based on a disposable syringe. Since then we have found a simpler method of construction. The syringe has a small hole about 2mm diameter drilled at the base of the body as shown in diagram. To operate, start with piston fully in, cover hole with thumb of left hand and draw out the piston. When the liquid is up to a suitable level use the thumb to control the inlet of air to adjust to the desired graduation mark. The capacity of syringe should be at least equal to that of delivery volume of the pipette.



S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Tel. 031-556 2184.

Australian Science Education Project, 11 Glenbervie Road,
Toorak, Victoria, Australia 3142.

Bardic Systems Ltd., Southampton.

Cleapse Development Group, Brunel University, Kingston Lane,
Uxbridge, Middlesex.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride.

National Radiological Protection Board, 11 West Graham Street,
Glasgow, G4 9LF.

(Quickfit) Jobling Laboratory Division, Tilling Drive, Stone,
Staffs, ST15 0BG.

Radford Electronics Ltd., Ashton Vale Road, Bristol, BS3 2HZ.

R.S. Components Ltd., P.O. Box 427, 13-17 Epworth Street,
London, EC2P 2HA.

G. Springham and Co. Ltd., Temple Fields, Harlow, Essex.